Low Cost Course Correction Technology

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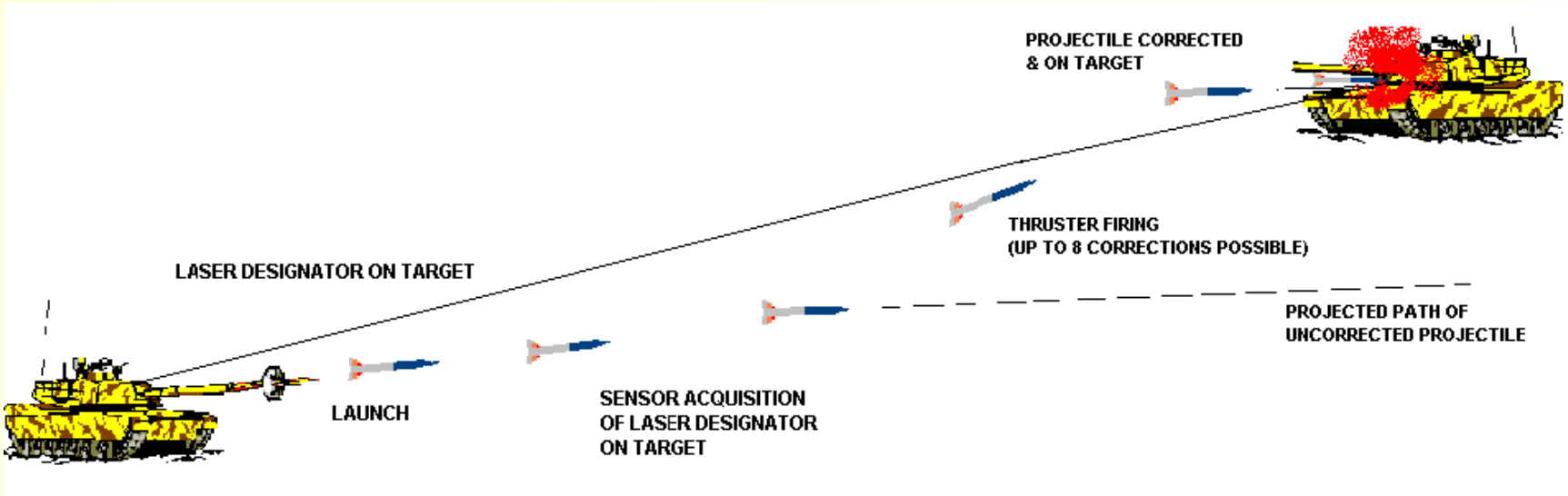
Objective

Conduct a proof-of-principle demonstration of the Low Cost Course Correction Technology (LCCCT). The LCCCT will provide enhanced accuracy and improved dispersion by adjusting trajectory in-flight to compensate for system errors under all conditions and resulting in an improved P_h / P_K

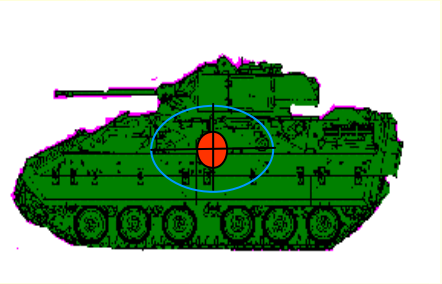


Projected Improvement In Dispersion

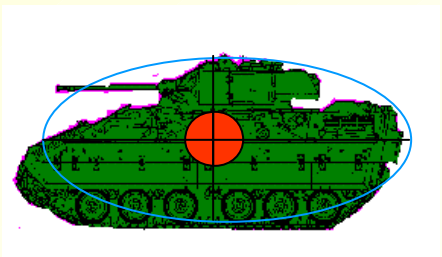
Goal

Demonstrate approximately the same or better dispersion at 3000m+ as current round delivers at 1000m

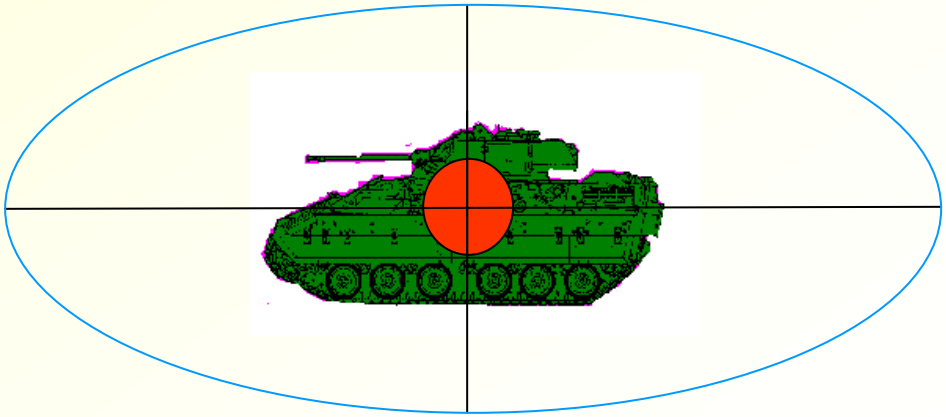
1000 METERS



2000 METERS



3000 METERS



UNGUIDED BULLET

GUIDED BULLET

Benefits of LCCCT for Munitions

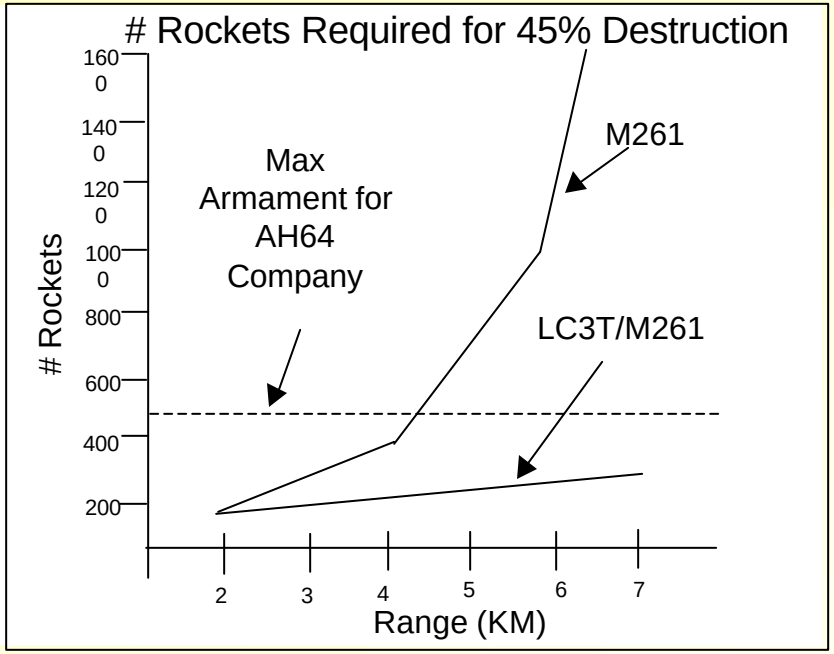
- **Offers substantial predicted increase in accuracy**
  - **2.75” Rockets: 30 mils to 5 mils**
  - **30mm HEDP : 12 mils to 1 mil**
  - **40mm: 3 meters @ 3km to 1 meter@ 3km**
- **Increases in accuracy provide:**
  - **Increases in tempo of battle allowing defeat of enemy much quicker**
  - **Increased survivability due to longer standoff and increased first shot Pkill**
  - **Reduction in fratricide**
  - **Reduces logistic burden by increasing stowed kills**
- **No platform changes required**
- **Suitable for guiding high spin rate (>15 rps) munitions:**
  - **Most other guidance approaches do not work well in a high spin rate environment**
  - **LCCC uses spin for guidance signals and to position microthrusters for divert event**

Effectiveness Analysis of LCCCT Munitions

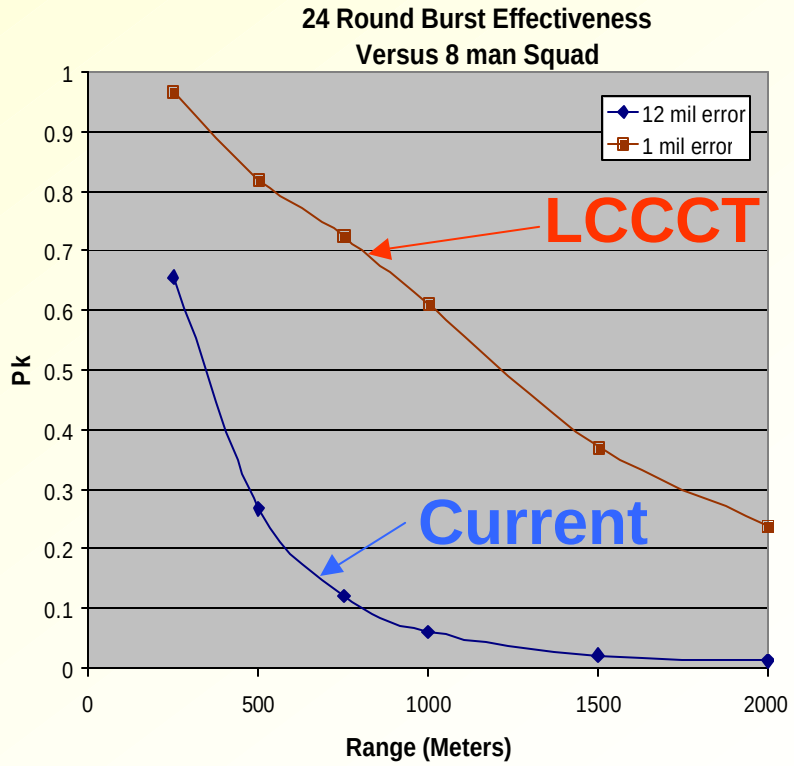
2.75” HYDRA-70 Rocket

GENERAL DYNAMICS
Ordnance and Tactical Systems

30mm HEDP

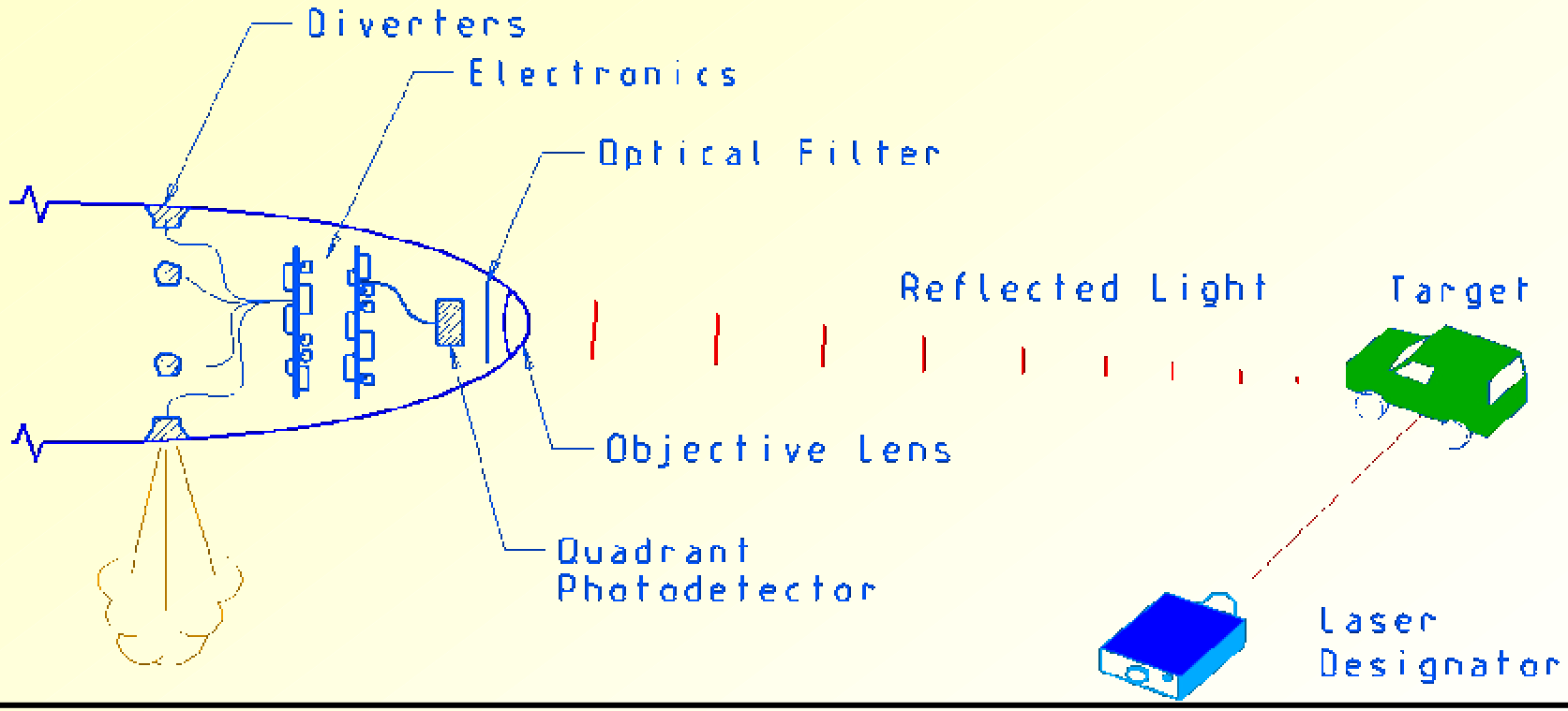


- **Target -dismounted motorized infantry company**
- **Significantly fewer rounds required to defeat target with more accurate rocket**



Improved Pkill with fewer rounds offered by LCCCT

Low Cost Course Correction Guidance Approach



- **Improve CEP of rockets and bullets using body fixed guidance approach**
- **Employ control system after build up of angular error exceeds threshold**
- **Fast impulse thrusters for control authority**
- **Low cost seeker using using off the shelf components**
- **Guidance approach suitable for spinning projectiles and currently fielded laser designators**

Approach

Conduct detailed effectiveness analysis to quantify the benefits of LCCCT for medium caliber systems:

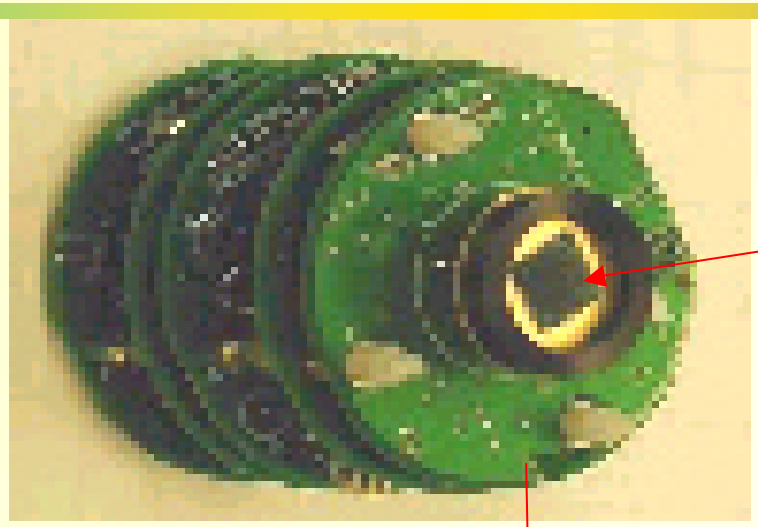
- **Conventional uses in air and ground platforms**
- **Ship defense against small attack boats and incoming missiles, i.e. Phalanx improvements**
- **Ground platform as Active Protection System (integrate with Fire Control to engage incoming missiles and fallers) for FCS platforms**

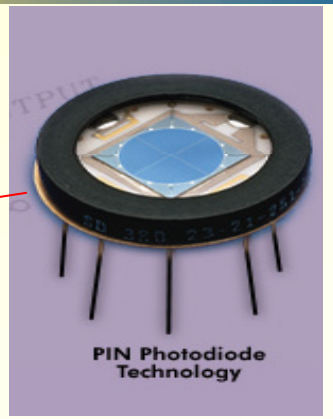
Utilize 2.75” Rockets, 40 mm cartridges and 120 mm tank rounds as carriers for the LCCCT hardware to develop and mature the key technologies:

- **Shrink optics, electronics, and thrusters to medium caliber size**
- **Gun Hardening of components to withstand high acceleration loads of (50-100 kG)**

Seeker/Diverter Flight Test Unit

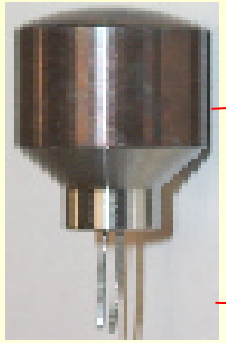
Electronics Assembly

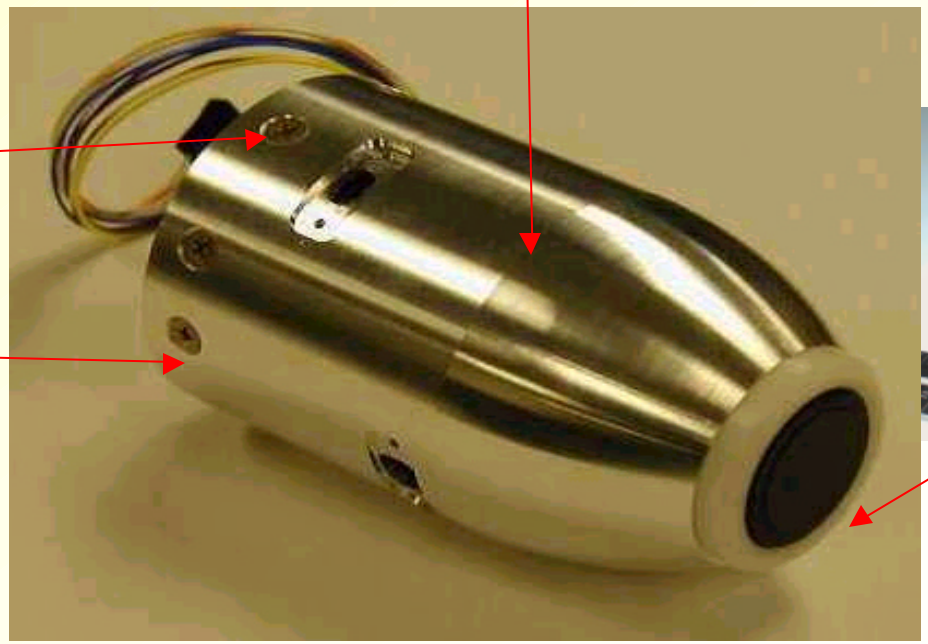


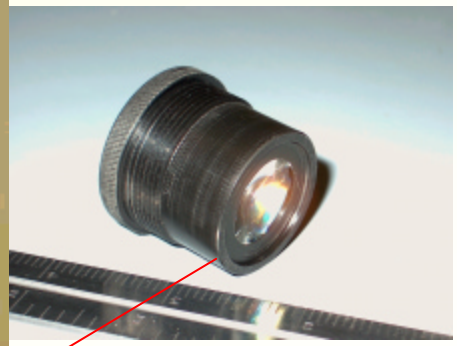


Quadrant Detector

Diverter







Lens Assembly

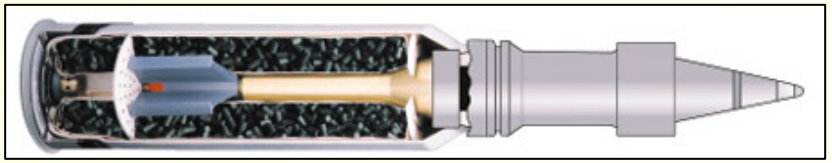
Technical Challenges

- **G-Hardening: must withstand gun-launched, direct fire, setback loads of medium caliber ammunition (50-100kG)**
- **Component packaging: reduce size from current 3.5” diameter to 40mm diameter for medium caliber applications**
- **Compatibility with existing laser designators: pulsed vs. continuous wave, coding**
- **Diverter effectiveness: power, response time**
- **Number of course corrections required vs. time of flight: space for diverters**
- **Environmental factors: smoke, rain, fog etc.**
- **Cost: Near term: <$1k modification to 2.75” rocket**

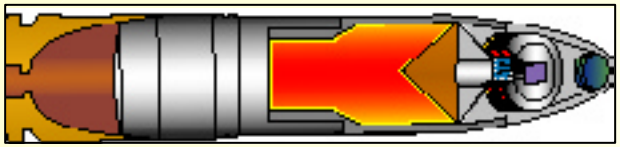
  Far term: <$100/complete round for medium caliber

Applications

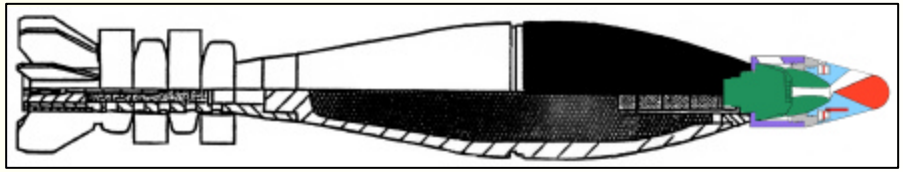
2.75” Rockets



Tank Ammunition



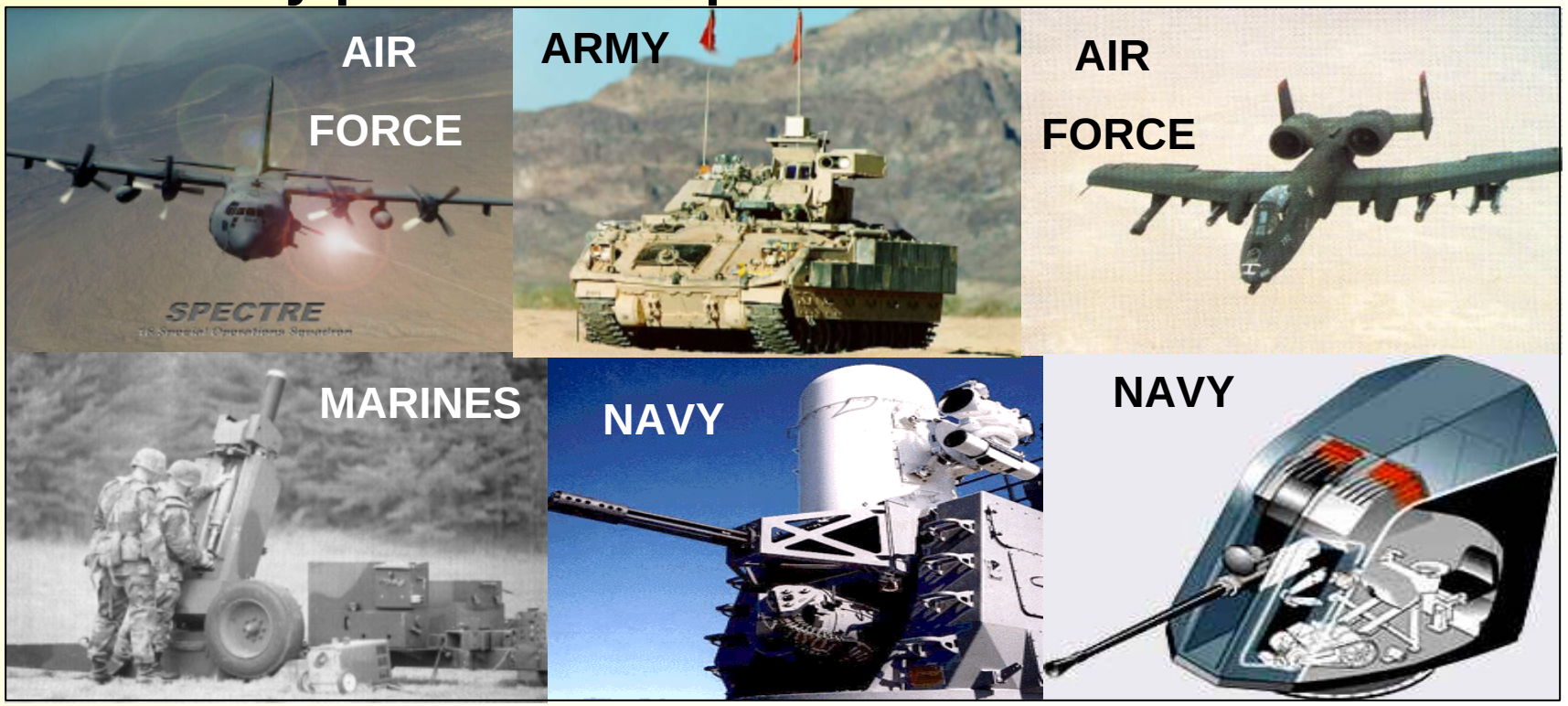
Medium Caliber Projectiles



Mortars

Applicability to other Services

- **Suitable against ground, air and naval targets.**
- **Can be applied to gun launched projectiles, mortars, and rockets.**
- **Relatively platform independent.**



Progress/Accomplishments

- **Jun 01** - Conducted laser seeker sensitivity tests at the Automated Laser Seeker Performance Evaluation System (ALSPES) at Redstone Arsenal. Verified seeker can detect the laser signal at 500m and has a +/-12 degree field of view.
- **Jun 01** - Conducted flight tests of 3.5" projectiles to verify aero design. Projectiles were aerodynamically stable and flew as predicted on the 600 ft test range.
- **Jun 01** - Conducted shock table and air gun high-g testing. Electronic/Optics assembly survived at 15kG, redesign in progress to 50kG
- **Aug 01** - Conducted flight tests to verify seeker functioning. Seeker acquired target and issued fire commands as expected.
- **Dec 01** - Conducted flight tests and fired diverters upon command from seeker. Diverters fired on command and diverted projectile as predicted.

3.5” LCCCT GUN TESTING

GD-OTS BALLISTIC TEST RANGE – NICEVILLE, FL

Multi-layered Soft Catch Target

LED Target
(40’ to side of target)

Target

3.5” Gun

3.5” LCCCT Projectile

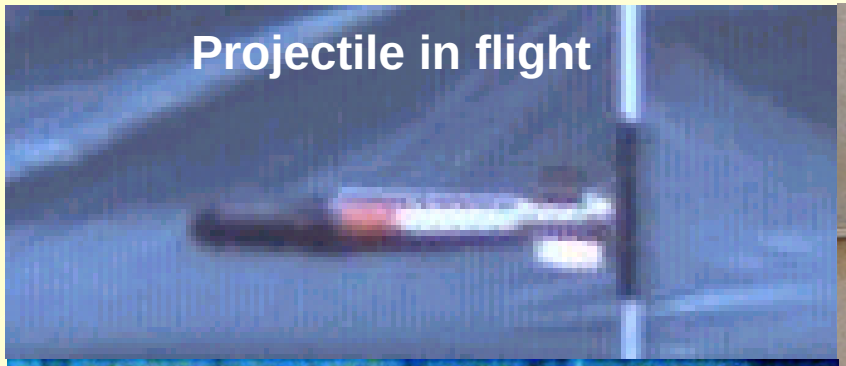
Test Parameters

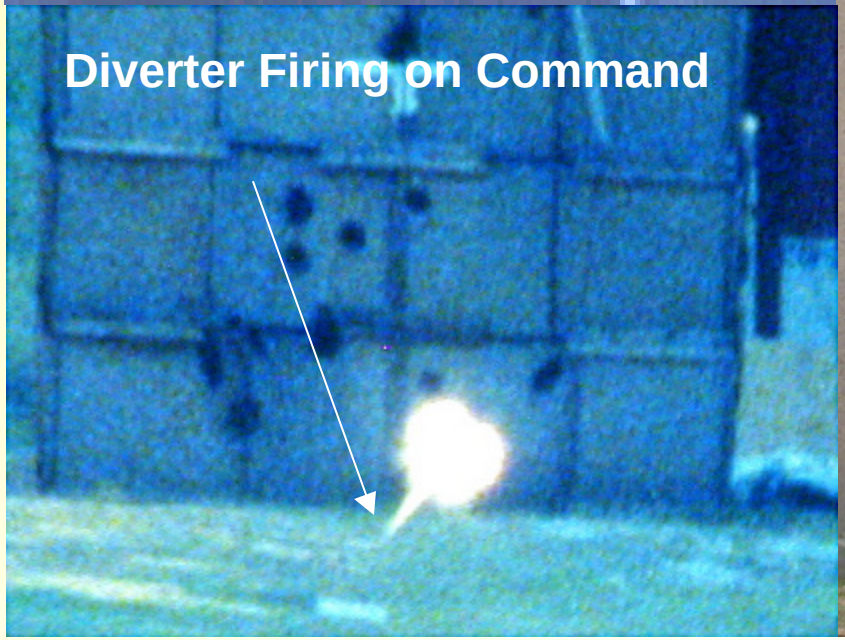
- 600 ft Flight
- 15 lb Projectile
- 500 fps velocity
- 500 gee setback
- 12 rps spin@300’

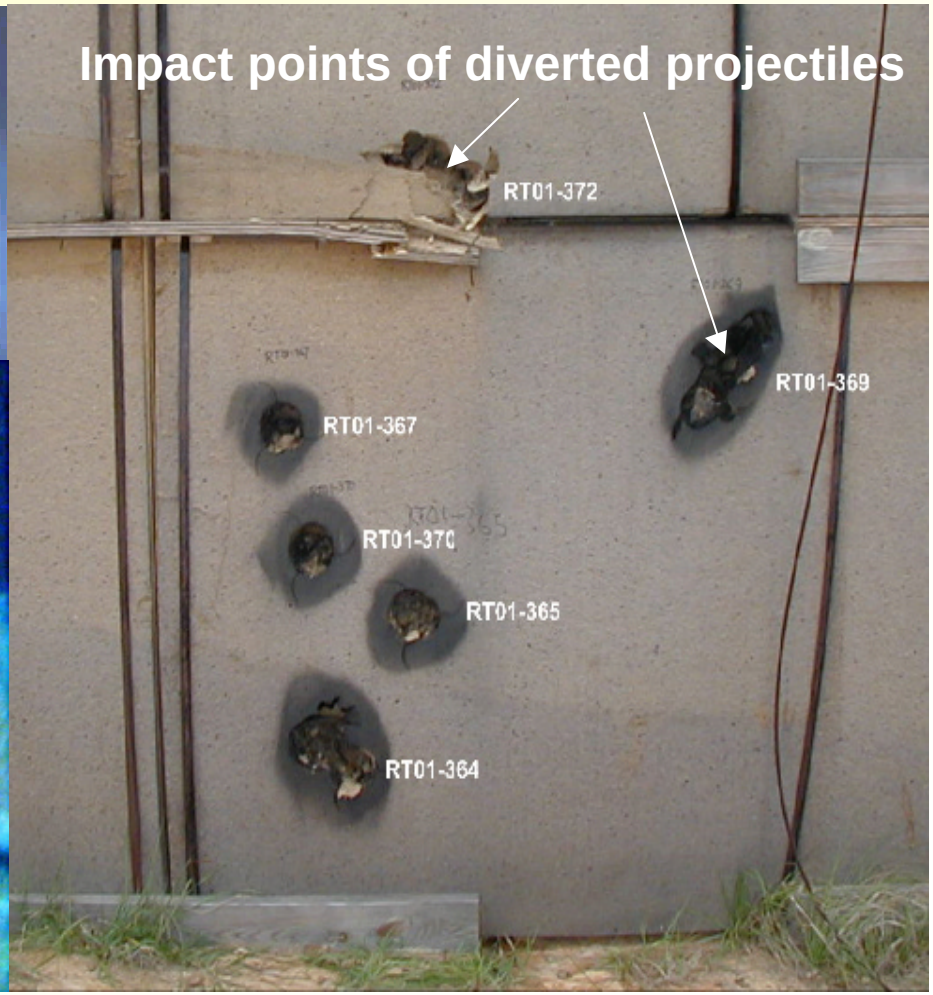
Projectile Soft Catch in Rubber Filled Target

Seeker parameters set at Pre- Launch

3.5” LCCCT GUN TESTING







Dec 2001 Flight Test RT-0169 S/N 006

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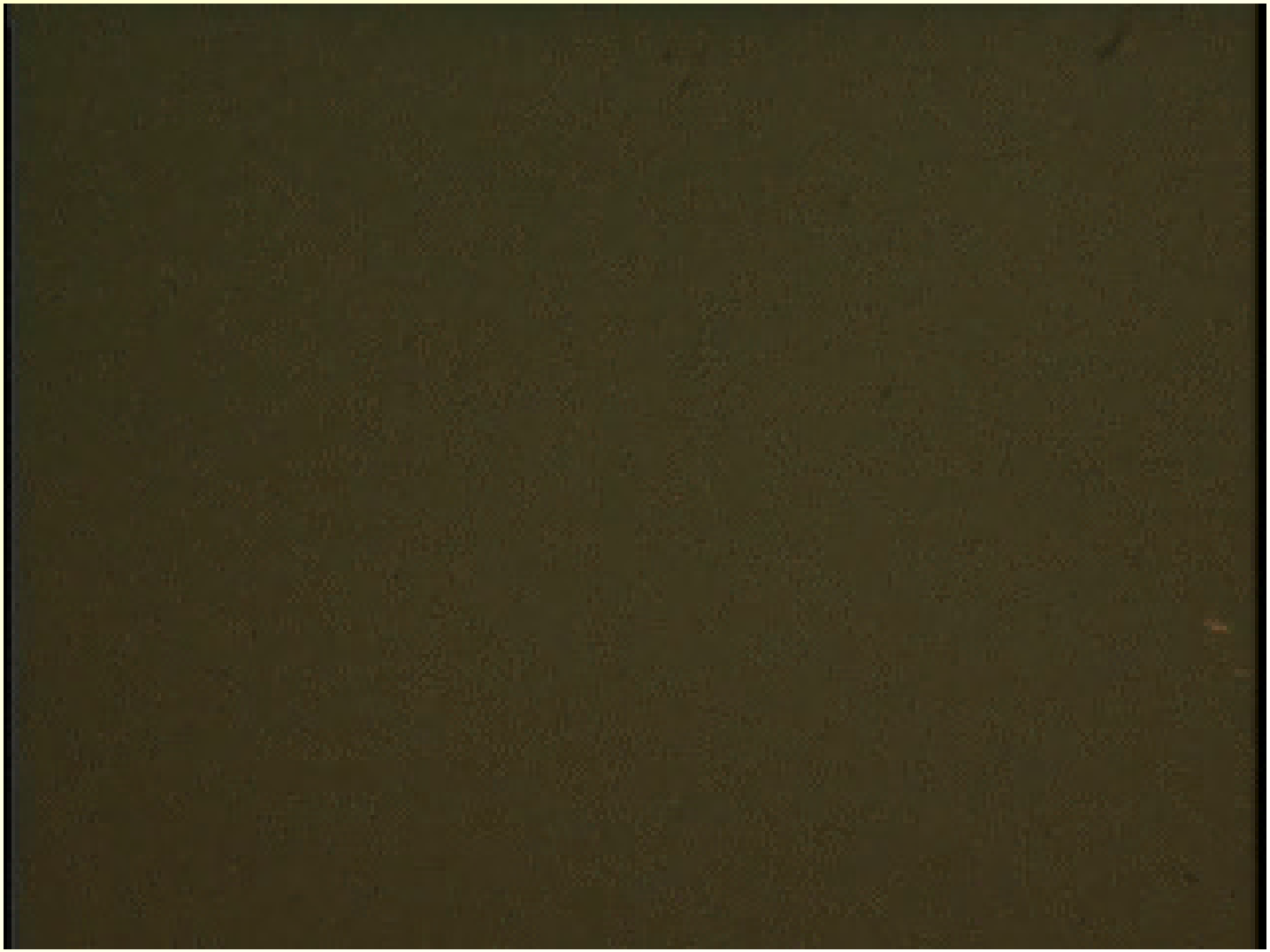

Summary

- Affordable guidance is the key to future military effectiveness.
- Significant accuracy improvement appears achievable with body fixed guidance approach employing fast impulse thrusters and a low cost seeker.
- LCCCT is applicable to new and existing munitions and rockets >40mm diameter
- Further work concentrating on demonstration testing and gun hardening of components